

EkonomickáJihočeská univerzitafakultav Českých BudějovicíchFacultyUniversity of South Bohemiaof Economicsin České Budějovice

Geographic Information Systems 1 Lecture 9: Spatial Data Analysis



University of South Bohemia, Faculty of Economics Renata Klufová April 20201



Spatial Analysis

- answer questions, support decisions, and reveal patterns
 - all of the transformations, manipulations, and methods
 - Data ----> Information ---> Understanding

 "a set of methods whose results change when the locations of the objects being analyzed change"



Which is Spatial Analysis?

 calculating the average income for a group of people?

 calculating the center of the Czech Republic population?



Types of Spatial Analysis

- Queries and reasoning
- Measurements
 - Aspects of geographic data, length, area, etc.
- Transformations
 - New data, raster to vector, geometric rules
- Descriptive summaries
 - Essence of data in 1 or 2 parameters
- Optimization ideal locations, routes
- *Hypothesis testing* sample to entire pop.



GIS Analysis Model (flowchart)

Residential areas in flood zone BUT

need spatial analysis to pinpoint locations





GIS Lanslide Susceptibility Model in ArcGIS Model Builder





2 Analysis Examples from ArcGIS

- Interpolation soil samples on a farm [transformation]
- Location Analysis coffee shops & customers [optimization]



"a set of methods whose results change when the locations of the objects being analyzed change"

- Interpolation soil samples on a farm
- Location Analysis coffee shops & customers

Soil Samples of Farm Area w/ Interpolation

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Interpolate samples, then query to find pH > 7 Farmer needs to treat these areas w/ammonium sulfate

GIS Analysis Model

Choose Interpolation Parameters

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Input points:	Soil samples	• 🞽		
Z value field:	PH			
Power:	2			
Search radius type:	Variable	•		
Search Radius Settings				
Number of points:	12			
Maximum distance:				
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IDW Interpolation

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Instead of hillshade, use raster calculator

Raster Calculator							? ×
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Result: areas that farmer should treat w/ammonium sulfate to lower the pH to 7 so that soil is balanced





The Farm

- Size = ~5.35 acres (233,046 sq ft. or 21,650 sq m)
- Combined size of new treatment areas = ~0.145 acres (6,338 sq ft or 588 sq m)
- Ammonium sulfate @ \$50.00 per acre
 Treat whole field \$267.50

– Treat only where needed - \$7.25

• Crop yield and treatment maps over time



"a set of methods whose results change when the locations of the objects being analyzed change"

• Interpolation - soil samples on a farm

• Location Analysis - coffee shops & customers

Best location for new Beanery w/ location analysis (distance & proxmity)

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Marketing questions

Jihočeská univerzita

in České Budějovice

v Českých Budějovicích

University of South Bohemia

- Too close to existing shops?
- Similar characteristics to existing locations?
- Where are the competitors?
- Where are the customers?
- Where are the customers that are spending the most money?



Shops w/in 1 mile will compete for customers Potential shops > 1 mile away

GIS Analysis Model





Straight line distance function

Straight Line		? ×
Distance to:	Shops	
Maximum distance:		
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Result: yellow/orange = close to shops purple/blue = farther away

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Density Function, Customer Spending

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Result: Dark blues are greatest density of customer spending

🔍 Coffee.mxd - ArcMap - ArcInfo

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Find areas 1 mile from an existing shop that are also in a high spending density customer area



Result: Best locations for a new Beanery

w/ proximity to an interstate highway, zoning concerns, income levels, population density, age, etc.

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Uncertainty in the <u>Conception</u>, <u>Measurement</u>, and <u>Representation</u> of Geographic Phenomena

- Previous examples assumed it didn't exist
- Conception of Geographic Phenomena
- Spatial Uncertainty objects do NOT have a discrete, well-defined extent
 - Wetlands or soil boundary?
 - Oil spill? pollutants or damage?
 - Attributes human interp. may differ



Uncertainty in Conception

- Vagueness criteria to define an object not clear
 - What constitutes a wetland?
 - An oak woodland means how many oaks?
 - Seafloor ages/habitats
 - What does a grade of "A" really mean??



Uncertainty in Conception



Ambiguity - y used for x when x is missing Direct indicators: salinity (x) or species (y) Indirect more ambiguous Wetlands (y) of species diversity (x)??



Uncertainty in Conception



- Regionalization problems
- What combination of characteristics defines a zone?
- Weighting for composites?
- Size threshold for zone?
- Fuzzy vs. sharp



- Physical measurement error
- Mt. Everest is 8,850 +/- 5 m
- Dynamic earth makes stable measurements difficult
 - Seismic motion
 - Wobbling of Earth's axis
 - Wind and waves at sea!





- Digitizing error, e.g.,
- Undershoots
- Overshoots
- Gafs"





- Misalignment of data digitized from different maps
- *Rubbersheeting* is a corrective technique





- Different lineages of data
- Sample vs. population



Uncertainty in Representation Raster Data Structure



mixels

Classification based on dominance, centrality?



Uncertainty in Representation Vector Data Structure



Points in cornersZones based on onlyof polysa few points

Uncertainty in Analysis: The Ecological Fallacy



(A)Before it closed down, the footwear factory drew its labor from its local neighborhood and a jurisdiction to the west (B) The closure caused high unemployment, but not among the service sector workers of Chinatown (C) a spurious relationship between Chinese ethnicity and unemployment



Uncertainty in Analysis Ecological Fallacy

an overall characteristic of a zone is also a characteristic of any location or individual within the zone

Factory w/no Chinese employees may have closed



Modifiable Areal Unit Problem (MAUP)

- number, sizes, and shapes of zones affect the results of analysis
- Many ways to combine small zones into big ones
- No objective criteria for choosing one over another



Path of boundary changes where high pop. is



Uncertainty of Geographic Phenomena

- Conception spatial, vagueness, ambiguity, regionalization
- Measurement field, digitizing, lineage
- Representation raster, vector
- Analysis ecological fallacy, MAUP



Thank you for your attention

